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ARM Facilities Newsletter

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Atmospheric Radiation Measurement Program

ARM

Winter Storms

Winter has set its sights upon us, just in time to make the holidays bright. Remembering the joy winter brought us when we were children might help us cope with the hazards and inconvenience of the season, but we can't avoid the coping.

The basic mechanisms that support summer storms also occur in winter storms. These mechanisms include low-pressure centers, warm fronts, and cold fronts. As winter approaches, the northern branch of the jet stream dips to the south, bringing cold polar air into the Midwest and Southern Great Plains states. Counterclockwise rotation around a low-pressure center allows relatively warm, moist air from the south to flow northward on the eastern side of the low. Cold air from the north is drawn southward, behind the low-pressure center. Sufficiently cold air and abundant moisture are two ingredients necessary to fuel a winter storm system. The intensity of a storm depends on the strength and position of the jet stream relative to the low-pressure center, as well as horizontal temperature gradients and upper-air disturbances.

The most frequent origin for snowstorms that affect the Southern Great Plains states is the lee of the Rocky Mountains. Low-pressure systems develop in this area and move eastward or northeastward, encountering and picking up moisture from the Gulf of Mexico. Such storms contribute to average annual snowfall levels over the ARM Program sites ranging from 5-15 inches in Oklahoma to 15-30 inches in Kansas.

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The types of precipitation that can fall from a winter storm include snow, sleet, freezing rain, and rain. The precipitation type that reaches the ground depends on

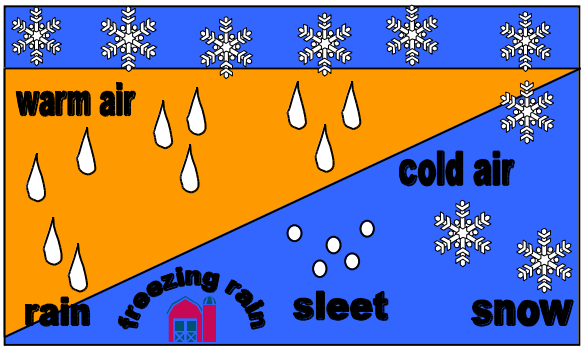

Figure 1. Schematic diagram showing the various types of precipitation resulting from overrunning, when warm air rides over colder air near the ground.

the air mass structure through which the precipitation falls and the relative positions of the low-pressure center and its associated warm and cold fronts.

Most winter precipitation is the result of overrunning, a condition in which the air from a warm sector of the low-pressure system catches up to colder air ahead. Because the warm air is lighter, it is forced up and over the slow-moving, denser cold air near the ground (Figure 1).

All precipitation begins as snow high up in the clouds. As it falls through a warm air layer, the snow melts. The depth of the warm layer (which depends on the position to the frontal boundary) determines the type of precipitation received at the surface. If the warm layer reaches the surface and surface temperatures are above the freezing point, the precipitation will fall as rain. Freezing rain occurs when melted snow refreezes as it lands on objects 32°F or colder at the surface. Freezing rain causes very dangerous conditions on the ground, because it adds weight to and can snap power lines and glazes over roads with a sheet of ice. In contrast, if the cold layer into which the melted drops fall is deep enough, the drops will refreeze before they hit the surface, forming small ice pellets more commonly known as sleet. If the warm layer is shallow enough or nonexistent, snow will reach the ground.

Most mixed precipitation falls to the south and east of the low-pressure center and in the warm sector south of the warm front. The heaviest snow falls to the northwest of the low's center, in the area of cold air flow, and is called "wraparound" snow (Figure 2).
The National Weather Service issues winter storm advisories as conditions warrant, usually 12 to 36 hours before a storm. A winter storm watch means that severe winter conditions, such as heavy snow, freezing rain, or sleet, are possible within the next day or two. A winter

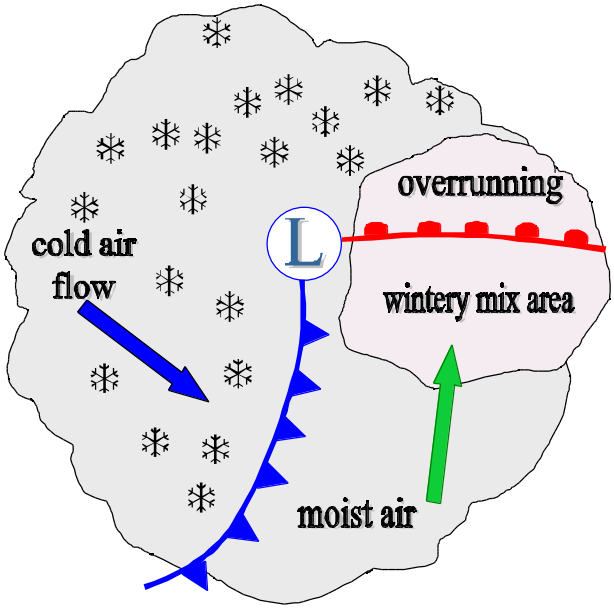

Figure 2. Schematic diagram showing a typical winter low-pressure system.

storm warning indicates that severe winter conditions have begun or are about to begin. Winter storms can intensify rapidly, making travel very dangerous. The most serious winter weather warning is the blizzard warning, which indicates that blizzard conditions with blowing and drifting snow are occurring. Blizzards can paralyze entire areas for days, making travel impossible because of whiteout conditions. Extreme wind chills and drifting snow can be life threatening.

Wind chill is another danger associated with winter weather. A term used to describe the rate of heat loss from the human body, wind chill results from the combined effect of cold temperatures and wind. As winds increase, heat is carried away from the body, lowering the skin temperature and eventually the internal body temperature. Exposure can be life threatening to both humans and animals, but it has no effect on inanimate objects such as automobiles. Figure 3 displays a typical wind chill chart. To calculate wind chill factor, use the following equation:

$$WC = 91.4 - [0.474677 - 0.020425*V + 0.303107*(V^{1/2})]*(91.4 - T)$$

Here: WC = wind chill factor
V = wind speed (mph)
T = temperature (°F)

Safety and preparedness are key factors in dealing with the extremes of winter weather. Knowing what to do when advisories are issued and what potential hazards exist will help us to avoid possible life-threatening situations this winter. Snow kills hundreds of people each year, primarily from traffic accidents, overexertion, and exposure.

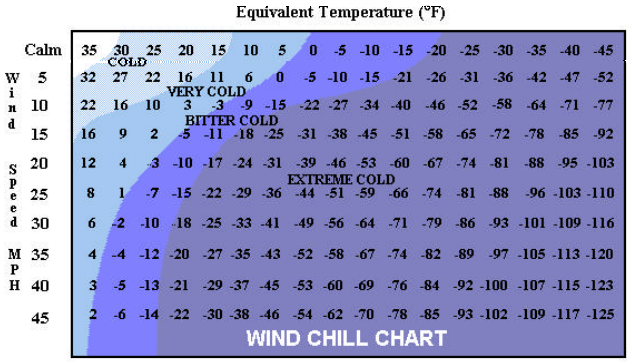

Figure 3. Standard wind chill chart. (Source: National Weather Service.)

Carrying an emergency road kit in your vehicle will help in case of an emergency. Protecting yourself from frostbite and hypothermia is vital when extreme temperatures prevail. The American Red Cross and the Federal Emergency Management Agency (FEMA) suggest several ways to prepare and respond to winter weather dangers.

On the Internet

Find out more about winter safety at these web sites:

American Red Cross

http://www.redcross.org/disaster/safety/winter.html

Federal Emergency Management Agency (FEMA)

http://www.fema.gov/fema/wsuc.htm